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SOCIETAL LIFE CYCLE ASSESSMENT

A comparison of cut roses from Ecuador and the Netherlands

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Abstract
Purpose There is a need to assess social impacts of products along the full life cycle, not only to be able to address the "social dimension" in sustainability, but also for potentially improving the circumstances of affected stakeholders. This paper presents a case study for a social life cycle assessment (S-LCA) based on the recently published "Guidelines for Social Life Cycle Assessment of Products" developed by the United Nations Environment Programme/Society of Environmental Toxicology and Chemistry (UNEP/SETAC) working group. General aim is to "try out" the proposed method. The case study itself compares the impacts of rose production in Ecuador with the Netherlands. Furthermore, the objective is to identify differences and similarities in environmental and social life cycle modelling and both social and environmental hot spots in each of the life cycles.
Methods The study considers the production of rose blossoms and the cutting and packaging process in two fictitious companies in Ecuador and the Netherlands. Both rose bouquets are delivered to the European market and auctioned in Aalsmeer, the Netherlands. The social assessment is based on the UNEP/SETAC guidelines for S-LCA. Data are mainly obtained from governmental and non-governmental organisations. For the calculation of the environmental burden, a screening-type LCA is conducted, including midpoint impact assessment.
Results and discussion This paper asserts that rose production in Ecuador is associated with many negative social effects, e.g. child labour, unfair salary, or bad impairment to health. The rose production in the Netherlands has no obvious negative social impacts but rather ecological consequences. Responsible for this is the high-energy consumption of the greenhouses.
Conclusions Application of the UNEP/SETAC guidelines in case studies can be encouraged based on results of this case study. The consideration of different stakeholder groups with corresponding, very diverse themes allows a comprehensive analysis of the actual conditions. However, finding suitable indicators to measure the status of the subcategories may be challenging. Moreover, the case study shows that results can be completely different for the environmental and for the social dimension, so that it often will be needed to perform both assessments if a complete picture is required.
Recommendations and perspectives It will be interesting to apply the UNEP/SETAC approach of S-LCA to other products; products with a more complex life cycle will be a special challenge. As with any new method, getting experience on data collection and evaluation, building a data stock, integrating the method in software, and finding ways for effective communication of results are important steps until integrating S-LCA in routine, recognized decision support.

Keywords Ecuador · E-LCA · Rose production · S-LCA · Social impacts · The Netherlands

1 Introduction

The analysis of ecological impacts of products and processes increased in popularity in the last decades due to an arising awareness both in society and economy caused by global problems like climate change, extinction of species or ozone depletion. However, the consideration of a social dimension in life cycle assessment (LCA) is still in its infancy, despite social ills, which are often related to globalization, and which are not necessarily related to environmental impacts. Thus, there is a need to assess social impacts of products along the full life cycle, not only for being able to address the "social dimension" in sustainability, but also for potentially improving the circumstances for affected stakeholders.

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Different approaches have been proposed to integrate social aspects in LCA or life cycle studies in general, e.g. from Dreyer and colleagues, Hunkeler, Norris, and Weidema. Proposed approaches are very diverse and vary regarding focus, indicators, impact assessment methodology, use of data, etc.

Weidema (2006), for instance, creates a new indicator "quality of adjusted life years" that is calculated via a combination of many different statistics (WHO World Health Report, Freedom house index on political rights, Kucera index on trade union rights, and others). The new indicator is to be understood similar to the DALY indicator of the WHO; it shall express reduced quality of living by shortening the life span.

Hunkeler (2006) considers only one single impact category, namely working hours, which are related to the product´s life cycle, as indicator to estimate other social impacts. Hunkeler assumes that process information can be obtained from labour statistics, and based on these characterization factors are calculated.

In contrast, Norris (2006) does not implement a new social indicator. His approach uses the existing LCA impact endpoint of human health. He developed a method, called life cycle attribute assessment, to label processes with attributes like "child-labor-free" or "best management practices" to enable an aggregation of site-specific information.

Dreyer lays emphasis on the need of site-specific data. Dreyer et al. (2006) point out that social impacts are primarily connected to the conduct of companies and less with processes in general. The proposed approach aims to reveal product/process improvement potentials to facilitate companies to act socially compatible.

Overall, while there is vivid activity recently on social assessment of products, there is no consensus yet on how to involve a social dimension in LCA and how to assess social impacts. An important step was the publication of the United Nations Environment Programme/Society of Environmental Toxicology and Chemistry (UNEP/SETAC) guidelines for S-LCA of products in summer 2009 (UNEP/SETAC 2009)—the first international accepted paper that describes an approach how to consider social impacts of products in a life cycle perspective analogous to the ISO standards for life cycle assessment (ISO 14040 and 14044). However, there are hardly any case studies that apply these guidelines so far.

A further problem in the investigation of social aspects is data availability. Relevant information is often difficult to obtain, especially with respect to critical aspects as working conditions, corruption, or anti-competitive behaviour. Generic as well as organisation- and site-specific data are needed for a comprehensive analysis. In addition, the quality of data is often difficult to assess for outsiders. Companies, employees as well as NGOs and GOs have under certain circumstances motives for misrepresentation of facts. Furthermore, data are mainly qualitative—thus, hard to quantify—and impacts are interrelated. There are many indirect effects, which cannot be clearly outlined.

2 Background information

2.1 General aspects of rose production

The production of roses is both capital and labour intensive.

Climate conditions are decisive for the production of high quality roses. The temperature must not exceed 28°C and not under-run 15°C. Roses consume relatively much water and require a constant humidity. Furthermore, they need a rain shield and minimal 10 h of sunlight daily. In principle, these requirements can be achieved with corresponding energy consumption artificially by greenhouses all over the world (GTZ 2004, p. 8).

Moreover, roses are very fragile to fungal attacks, viruses, and vermin in comparison to other agricultural products. Hence, a high appliance of pesticides is normal. Anyhow, there are great differences concerning used amounts and kind of pesticides.

In terms of distribution must be noticed that roses are among perishable goods. Therefore short hauls and foremost a chilled transport and storage is essential for product quality and durableness.

2.2 Ecuador at a glance

Ecuador is a small equatorial country in Latin America lying between Columbia and Peru with a total area of 280,000 km^2. According to estimates of the CIA, the population amounts 14.5 millions with an anticipated average of life of 75.3 years (rank 82 in international comparison) in 2010. The population consists of many different ethnic groups: indigenous people, immigrants from Spain and other countries, as well as Africans (CIA 2010).

The Ecuadorian economy has recovered from a grave banking and currency crisis in 1999/2000 by dint of structural reforms. Since the year 2000, the economic growth turned from negative into positive with an approximate average growth of 2.7% p.a. and gained stability (CIA 2010). However, Ecuador is one of the poorest countries in South America measured by the purchasing power parity per inhabitant. Furthermore, the income distribution differs significantly from urban to rural regions.

Main economic sectors are the oil branch with decreasing importance caused by resource depletion (ca. 10% of GDP in 2009), retail market (ca. 12.9% of GDP in 2009), and building industry (ca. 10% of GDP in 2009). Agriculture and forestry play a subordinate role (ca. 6.6% of GDP in 2009), although one third of population lives in rural areas and works in

agriculture. Foremost bananas, cacao, cut flowers, and coffee are cultivated (German Trade and Invest 2009).

Ecuador and the roses In Ecuador approximately 400 rose farms with 60,000 employees exist (Fian-Deutschland e.V. 2006, p. 8) and just 500,000 indirect employees (Batallas 2009, p. 8). Ecuador exports annually roses for ca. 300 million USD with an upstream tendency (Dreßler 2005, p. 22).

The climate of the Ecuadorian highlands is excellent for roses, so that no conventional greenhouses are necessary. The roses grow only under a foil greenhouse. Beyond that, roses in the Andes grow slower due to the attitude and thus their blossoms are bigger, their leaves are more robust and their colours are more intensive than in other growing areas.

Another advantage of location is the low wage level in Latin America, which allows a production only by handwork. The rose farms in Ecuador employ predominant female workers; child labour is also common. According to a study of the International Labour Organization (ILO) in 2005, 21% of the 5–17 years old children work in country average; in rural regions the percentage amounts even 36%; 80% of working children are employed in agriculture (ILO et al. 2005). Besides, the payment of workers is often far below the minimum wage. Every tenth child gets only a meal (Haupt 2002; ILO 2004).

Furthermore, the working time oscillates approximately between 72 and 84 h/week[1]; children work 10 h/day, 5 days a week. In the majority of cases, overtime is not paid and workers do not get a labour contract (FIAN-Deutschland e.V. 2006, pp. 8; ILO 2004; Batallas 2009, p. 9).

Another aspect is the damage caused to worker´s health due to a broad use of pesticides. Employees suffer from acute and chronic poisoning, which is attended by multifaceted ailments. They suffer from asthma, develop cancer, or their genotype is changed (Batallas 2009, pp. 15; Haupt 2002).

Already in 1984, the association of Ecuadorian flower producers "Expoflores" was established in Quito with the aim to stand up for more social responsibility among other things. Expoflores initiated the program "La Flor de Ecuador", which includes social and environmental standards. Member companies that are up to these requirements receive certification (Expoflores 2010; Mc Gowan 2006).

In recent years the Ecuadorian governance tried to combat child labour by investing in education and health care. In addition, fines on child labour were imposed and inspections in companies implemented (Aktiv gegen Kinderarbeit 2010).

There is international engagement in Ecuador, too. The international human rights organisation FIAN published a code of conduct, which aims to improve social and environmental conditions of the flower production under the name "Flower Label Program". However, at the moment not even 50 of 400 plantations are certified (FIAN-Deutschland e.V. 2009).

2.3 The Netherlands at a glance

The Netherlands are a small country in Western Europe bordering the North Sea. It extends over a total area of 40.000km^2 with a population density of 16.7 millions. Average life expectancy is 79.4 years (rank 30 in international comparison) (CIA 2010).

The Netherlands have a flourishing and liberal economy. In 2009, they recorded a GDP of US $795 billion. Due to the economic crises the estimated real growth rate was −3.9%. The unemployment rate increased to 4.9% (CIA 2010).

The service sector is deemed to be the most important sector with a GDP contribution of nearly 70%. The most important industry is food processing. Moreover, transport plays a significant role. The Netherlands are known for their excellent infrastructure. The agricultural sector becomes less important. Due to high automatization of Dutch agriculture, this sector employs hardly 3% of labour force (Außenwirtschaft Österreich 2009; CIA 2010).

The Netherlands and the roses Some years ago the production of cut flowers in the Netherlands was an important economic sector. At present the sector becomes less relevant. Due to strong competition from Africa, Asia, Middle East, or Latin America, Dutch rose producers try to hold against with high technology. Thus the rose production in the Netherlands is characterized by fully automated greenhouses in which robots cut the roses growing in liquid fertilizer. Via computers, even seasons are simulated. At night the greenhouses are lighted up to expedite growth, while in daylight they are darkened to slow growth. This high degree of automation enables indeed an optimized usage of water, fertilizer, and pesticides. On the other hand it consumes lots of energy – particularly in winter. In addition, automation implicates less employment (Bauer 2004; Steinkirchner and Busch 2007).

In spite of the aforenamed development, the Dutch position as linchpin for cut flowers is undisputed up to now.

3 Goal and scope

3.1 Objectives

This paper has three main objectives. First objective is to conduct a case study that is based on the methodology of the UNEP/SETAC guidelines for S-LCA. Due to the novelty of the S-LCA approach,[2] this case study has also the function to "try out" the method on a practical case to

[1] Some sources specify 52 h per week (GTZ 2004)

[2] This paper was submitted October 2009.

get experience on problems the method may cause in practical applications, and to demonstrate if and how far the method is applicable. Insight into required effort and into results that can be obtained is expected.

Second goal is the development of an assessment method for social impacts, which is suitable also for qualitative data and can be conducted easily. The impact assessment method should enable the identification of social hot spots in product life cycles as the UNEP/SETAC approach suggests many different and divers subcategories and indicators.

The case study itself aims for a comparison of the social effects caused by the production of a rose bouquet in Ecuador and the Netherlands. It will further assess the environmental impacts, and compare these to the social effects. In this way differences and similarities in environmental and social life cycle modelling can be identified.

A further motivation for the case study is to investigate trade-offs and possibly conflicting effects of rose production. The production of cut flowers in Africa, Latin America, and Asia said to have many negative, and not only social, effects. Foremost the heedless handling with pesticides and the intensive water use causes impacts on society and environment. On the other side, provided jobs reduce unemployment and paid wages can foster the economic situation at the production sites. For the case study, the production in Ecuador and the Netherlands is considered, since both countries produce roses with high and comparable quality. In addition, it is a matter of a developing country and a developed country.

3.2 Scope, functional unit, and system boundary

The S-LCA scope involves the rose blossoms producing process and the harvesting process. It is assumed that these represent the "social hot spots".[3] The described system complies therefore with the "gate-to-gate" principle. This means, that the culture of rose plants and the cottage are out of examination. It is assumed that these processes are located for both cases in Germany and that the negative social impacts are rather low. Regarding the environmental analysis, the different transport routes were taken into account.

In addition, the disposal is disregarded due to lack of reliable data. Roses are of course biodegradable, but might potentially contain residues of pesticides.[4] Disposal of packaging is as well not included for similar reasons.

Out of consideration are capital goods for simplification reasons. This is done although the production of capital goods is different in both countries, but this difference is probably not that relevant regarding the assessment of social effects. The setting of the system boundaries is primarily used for simplification. Focus on rose production and harvesting is also a matter of time and effort. The study could be extended later on. For a reliable and meaningful S-LCA study, the entire life cycle should be taken into account.

Both LCAs follow the principle of an attributional LCA, which aims at describing the properties of the existing life cycle.

The functional unit is a bouquet of roses with 20 caulis per spray, packaged and transported to the flower auction in Aalsmeeer, the Netherlands. The considered market segment is long stemmed roses. It is assumed that the quality of the roses produced in Ecuador and the Netherlands do not differ, even if the quality of roses is commonly better in Ecuador.

The social utility of roses is rather low. Roses are mainly used for decoration. In addition, roses are applied in the pharmaceutical industry for cosmetics.

Figures 1 and 2 illustrate the production systems in Ecuador and the Netherlands.

3.3 Method

The study considers the production of a rose bouquet in two companies in Ecuador and the Netherlands (gate-to-gate principle). Assumptions were modelled in a way that they picture the reality. Data sources are mainly from governmental and non-governmental organisations as ILO, CIA, FIAN-Deutschland e.V., EU, GTZ, or UNICEF.

As mentioned above stakeholder categories, themes of interest (subcategories) as well as social impact categories are based on the UNEP/SETAC guidelines for social life cycle assessment, which follow the international standards for E-LCA (ISO 14040 and 14044). In order to be able to summarize results and indicators of a different nature, an interpretation and assessment method was newly developed. It uses a simple colour system to evaluate the social impacts of each subcategory based on the status of different indicators. It aims to be readily understood and intuitive, and to quickly give an overview over existing problematic issues. Although the assessment is innately subjective, objectivity can be achieved using international accepted standards as performance reference points. For instance, national minimum wages provide a basis for the assessment of fair salary. Wages below the legal minimum wage are classified as unfair salary. Indeed, even minimum payment does not automatically ensure a decent living standard. In many countries the minimum wage is too low, so that a living wage serves as a measure.

[3] Definition according to the UNEP/SETAC guidelines: "Social hotspots are unit processes located in a region where a situation occurs that may be considered as a problem, a risk or an opportunity, in function of a social theme or interest. The social theme of interest represents issues that are considered to be threatening social well-being or that may contribute to its further development."

[4] According to analyses in Germany, almost all cut roses contain pesticides including very harmful pesticides which are prohibited in the EU (Plus minus 2009; Stiftung Warentest 2007).

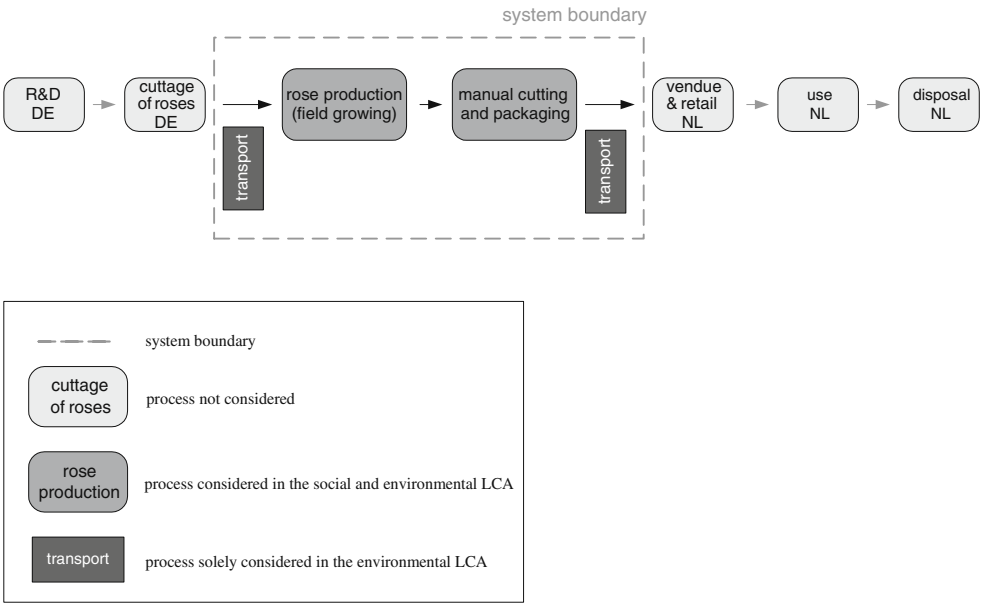


Fig. 1 Product life cycle of cut roses and considered system with system boundaries, for Ecuador

As relevant Stakeholders for the considered processes the following groups with subcategories were identified:

- *Workers*: farm workers in Ecuador and employees in greenhouses in the Netherlands; considered subcategories: freedom of association, child labour, fair salary, working hours, forced labour, health and safety, social benefits
- *Supply chain actors*: the fictitious companies "Flower Power" in Ecuador and "Verbloemd" in the Netherlands; considered subcategories: fair competition, promoting social responsibility
- *Local community*: region Pichincha in Ecuador, region Noordholland in the Netherlands; considered subcategories: respect of indigenous rights, safe and healthy living conditions, local employment
- *Society*: the Ecuadorian and Dutch society; considered subcategories: contribution to economic development, corruption, technology development, prevention of armed conflicts
- *Consumers*: the rose buyer in flower shops; considered subcategories: health and safety, transparency

Considered impact categories are:

1. health and safety,
2. socio-economic repercussions,
3. human rights,
4. indigenous rights (including cultural heritage), and
5. development of the country.

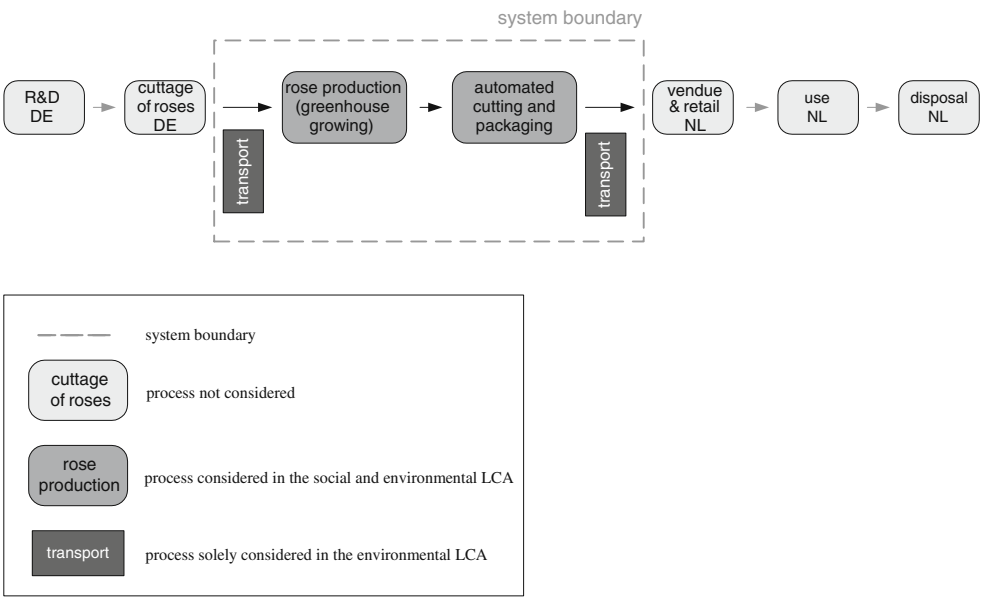


Fig. 2 Product life cycle of cut roses and considered system with system boundaries, for the Netherlands

Every subcategory is assessed by dint of different indicators, which are listed in the social inventory. Whether a subcategory influences an impact category is visualized in the tables with a check mark. Note that it is only taken into account, whether the subcategory has in this special case an impact, not if there is an impact in general. For example, forced labour is not present in this case study and has thus no effects. If forced labour would be present, it would have negative impacts. This impact assessment method considers among potential impacts also real impacts.

The relation between subcategories and impact categories is not described in this article, because it would be too comprehensive. The correlations are in most cases self-explanatory. Due to the lack of cause–effect chains of social impacts, the connection between subcategories and impact categories bases on own thoughts.

For the calculation of the environmental burden no single processes, but the whole life cycles were analysed. Regarding the processes located in the Netherlands the ecoinvent database was used. To account for the lower technical standard in Latin America older data sets from Buwal 250 and Idemat 2001 were utilized. The applied impact assessment method is CML with following impact categories:

1. abiotic depletion,
2. acidification,
3. eutrophication,
4. global warming,
5. ozone layer depletion,
6. human toxicity,
7. fresh water aquatic ecotoxicity,
8. marine aquatic ecotoxicity,
9. terrestrial ecotoxicity, and
10. photochemical oxidation.

4 Inventory analysis

In the following section the inventory is itemised. Among the environmental inventory data also social inventory data in the form of social indicators are outlined.

First, the rose producing process is considered per country and stakeholder group. Then the cutting and packaging process is listed; analysed per country and stakeholder group as well.

4.1 Rose producing

This process comprises the care of the rose plants (to water, to fertilize, to spray with pesticides, and so on) until they bloom. The duration of this process takes approximately 90 days. Basic assumption for modelling was a required area of $12m^2$ to harvest 20 roses/day, and that there is 1 plant/m^2. Since rose bloom is limited to two times of the year, each about 2 months, about 1.200 roses/year can be earned from $12m^2$.

4.1.1 Production in Ecuador

The following inputs are hypothetic (Table 1). The assumptions were made with the aid of other studies (e.g. GTZ 2004; Williams 2007) or internet research. Concerning the energy consumption in Ecuador, a special Ecuadorian energy mix was modelled based on data from the International Energy Agency (IEA 2006). The electricity consumption was calculated by the Dutch electricity need of rose production. The lifetime of the steel structure is estimated at 15 years and the lifespan of the foil is estimated at 2 years.

Social indicators

Workers

- There are no labour contracts at the company Flower Power; thus workers have, e.g. no right for association or social benefits (following Batallas 2009, p. 9; GTZ 2004, p. 10).
- Unequal opportunities for women at the farm; women and children are discriminated against (following ILO 2004; Batallas 2009, pp. 9).
- Child labour is common at the rose farm Flower Power (following ILO et al. 2005).
- The payment at Flower Power is below the legal minimum wage, children and women earn less than men; overtime is not paid (following Haupt 2002; ILO 2004; Batallas 2009, pp. 9).
- Assumed working time at the plantation is 72 h/week for adults and 50 h/week for child workers (following FIAN-Deutschland e.V. 2006, pp. 8; ILO 2004).

Table 1 Input–output table of rose production in Ecuador (per 20 roses)

Inputs		Outputs	
Greenhouse			
Land occupation (90 days)	12 m^2	Waste	–
Foil (LDPE)	0.04 kg	Waste water	–
Steel structure	0.08 kg	Emissions to soil	–
Pump station	1.66E−6	Emissions to air	–
Water	0.5 m^3	20 roses	
Electricity	25 kWh		
Fertilizer (1/5 K, 1/5 N, 3/5 P)	0.48 kg		
Pesticides	0.006 kg		

- Cases of forced labour are not known; adults and children have to work at Flower Power and other rose farms due to their poverty and lack of opportunities.
- Workers of Flower Power have protecting clothes, but it is damaged and/or unsuitable (following GTZ 2004, p. 9)
- Off-time after spraying with pesticides is not observed at the farm; thus the health of workers is at risk (following GTZ 2004, p. 9).
- Flower Power does not provide social benefits.

Company "Flower Power"
- Flower Power is a small Ecuadorian company; it has not enough market power to influence prices etc. Prices are set by purchasers.
- The company does not promote social or environmental responsibility, neither within the company nor for the region Pichincha; it is not certified.

Region Pichincha
- The Ecuadorian population consists of many ethnical groups, among also many different indigenous people. In the past, ethnical discrimination was widespread, today the situation is defused. Ecuador ratified the ILO convention 169 concerning the protection and integration of indigenous and tribal peoples in 1998. However, international organisations criticize the still prevalent discrimination (Amnesty International 2010). Also in the company occurs discrimination. Indigenous rights are violated.
- There is a high crime rate nationwide with a raising tendency, foremost tourists fall victim to assault (OSAC 2007). Due to bad working conditions the rose farms including Flower Power contribute indirectly to high crime. For instance, low income can involve miscellaneous offences as drug consumption, violence, or thefts. On the other hand workers cannot meet obligatory supervision regarding their children, because of long working hours, what can also contribute to high crime.
- In rural regions like Pichincha 60% of population live in poverty, 27% even in extreme poverty (GTZ 2008). Flower Power does not combat poverty as the salary is very low.
- Land use for agriculture leads to forest clearance and contamination of ground water and soil. Hence, rose farms like Flower Power contribute to environmental pollution and decline healthy living conditions.
- The unemployment rate is about 8%, but almost 45% of employees are underemployed and there is a large difference between urban and rural regions (Germany Trade and Invest 2009). Flower Power provides important jobs in rural regions.

Society
- Ecuador exports roses for 300 million USD per year, which can be seen as a significant contribution to economic development of the country (Dreßler 2005, p. 22; Batallas 2009, p. 6). However, the contribution of the sector to economic development is limited. Due to low wages the buying power of the workers increases only little. This is also valid for Flower Power.
- Corruption rate is estimated high. According to Transparency International the corruption index is 2.2 (rank 146 in international comparison) (Transparency International 2010). Also in the company corruption is widespread.
- The technical status in Ecuador is in general underdeveloped. There is only a moderate progress. The rose farms including Flower Power do not promote technology development due to the low automatization and lacking resources.
- There are relatively often armed conflicts in Ecuador due to political instability and social pressure (OSAC 2007; Heidelberg Institute for International Conflict Research 2009), but the rose plantations are not actively involved in the conflicts. They promote them indirectly because of the poor conditions. Also, Flower Power abets the development of conflicts through its behaviour.

Consumer
- The consumer of the roses, situated in Europe, is not involved or otherwise directly affected in this process.

4.1.2 Production in the Netherlands

Table 2 shows the assumed inputs of the rose production process located in the Netherlands. These estimations are mainly based on other studies (e.g. GTZ 2004; Williams 2007; Djevic and Dimitrijevic 2010). The electricity demand is one third caused by lightening (3,600 W lamps burning in an average of 5 h/day) and two thirds by machinery, robots, and irrigation. The natural gas is used for heating. It is assumed that the durability of the steel structure is 20 years and the one of the glass 10 years.

Social indicators

Workers
- Workers have generally the right to form and join unions (CIA 2009).
- The company has a policy for equal opportunities and promotes the employment disabled people.
- No cases of child labour in the company.
- Payment amounts—depending on position—not less than the minimum wage except for students under 22; the minimum wage is 1,416 €/month (following Eurostat 2010) which ensures a decent living standard
- Average working time in the company amounts 38 h/week, overtime is paid and regulated in labour contracts (maximum overtime is 55 h/week) (following Agri-info 2007).

Table 2 Input–output table of rose producing in the Netherlands (per 20 roses)

Inputs		Outputs	
Greenhouse			
land occupation (90 days)	12 m^2	Waste	–
flat glass	0.48 kg	Waste water	–
steel structure	0.1 kg	Emissions to soil	–
lamps	–	Emissions to air	–
sunblinds (HDPE)	0.000875 kg	20 roses	
Pump station	1.44E−6 p		
Rock wool	–		
Water	0.4 m^3		
Electricity	154.75 kWh		
Natural gas	117.02 m^3		
Fertilizer (1/5 K, 1/5 N, 3/5 P)	0.24 kg		
Pesticides	0.002 kg		

- No cases of forced labour in the company.
- Workers have protecting clothes, in addition operations with hazardous substances are executed by machinery.
- Working conditions meet the ILO conventions (following ILO 2010) and exceed the standards by far; employees are covered by social insurance

Company "Verbloemd"

- Verbloemd acts fair and do not cartelize or monopolize; Verbloemd cannot influence market prices.
- The company takes over ecological responsibility optimizing processes and using eco-friendlier substances and materials, the company is ISO 14001-certified

Region Noordholland

- There is no indigene population that is potentially discriminated against, even though the Netherlands ratified the ILO convention 169 for protection of indigenous and tribal people as a sign of solidarity in 1998 (ILO 2010).
- The Netherlands have a commendable welfare system avoiding (extreme) poverty (Welt 2008). Verbloemd contributes with fair salary and social benefits.
- The Netherlands show a low crime rate (Statistics Netherlands 2009) and Verbloemd does not promote crime. Thus Verbloemd does not endanger safe living conditions.
- Verbloemd contributes to environmental load mainly by the very high-energy consumption, what affects healthy living conditions.
- The unemployment rate of Noordholland is very low (Wikipedia 2006), but Verbloemd provides only a few jobs due to the high degree of automatization.

Society

- The relevance of cut flower production in the Netherlands decreases, but there is still a nameable economic contribution—as well from Verbloemd.
- The corruption rate is estimated as low (Transparency International 2010), equally the corruption rate in the company Verbloemd.
- Verbloemd promotes high-tech development, trying to resist competition by high technology (Bauer 2004; Steinkirchner and Busch 2007). In particular, eco-friendly technologies are expedited.
- There are no armed conflicts in the Netherlands (Heidelberg Institute for International Conflict Research 2009). Rose producers are neither involved in conflicts nor they increase the risk of conflicts.

Consumer

- The consumer of the roses is not involved or otherwise directly affected in this process.

Table 3 Input–output table cutting and packaging in Ecuador (per 20 roses)

Inputs		Outputs	
Paper	0.1 kg	Waste	–
Paperboard container	0.25 kg	Waste water	–
Cold storage room	For 1 kg	Emissions to soil	–
Transport (by lorry and plane)	9.628 kg km	Emissions to air	–
Energy	–	1 bouquet of roses	

4.2 Cutting and packaging

In this process, 20 roses are packaged to a bouquet with paper. Then bouquets are boxed into a paperboard container. Every cardboard box contains 300 roses. The containers are transported and stored in a cold storage room.

Basic assumption of this process was that one rose bouquet weights 1 kg. In addition, the packaging paper weights 0.2 kg/bouquet and the box weights 0.4 kg/bouquet.

4.2.1 Cutting and packaging in Ecuador

Table 3 illustrates the different inputs of this process. The inputs of this process are also estimations.

Social indicators

See 4.1.1 for stakeholders workers, value chain actors, local community, and society

Consumers

- Consumer health and safety can be affected by pesticide content of the flowers, Ecuadorian statutory provisions prohibit the use of pesticides, which are forbidden in Europe or the USA, but these regulations can be circumvented easily[5] (Haupt 2002).
- There are no mandatory regulations regarding transparency about working conditions or production; it exist only voluntary guidelines, which include the publication of data as for example an ISO certification. The rose plantation does not publish any corporate social responsibility data.

4.2.2 Cutting and packaging in the Netherlands

The assumed inputs of this process in the Netherlands are pictured in Table 4.

Social indicators

See 4.1.2 for stakeholders workers, value chain actors, local community, and society

Table 4 Input–output table cutting and packaging in the Netherlands (per 20 roses)

Inputs		Outputs	
Paper	0.1 kg	Waste	–
Paperboard container	0.25 kg	Waste water	–
Machinery and robots	–	Emissions to soil	–
Cold storage room	For 1 kg	Emissions to air	–
Transport (by lorry)	50 kg km	1 bouquet of roses	
Electricity	1 kWh		

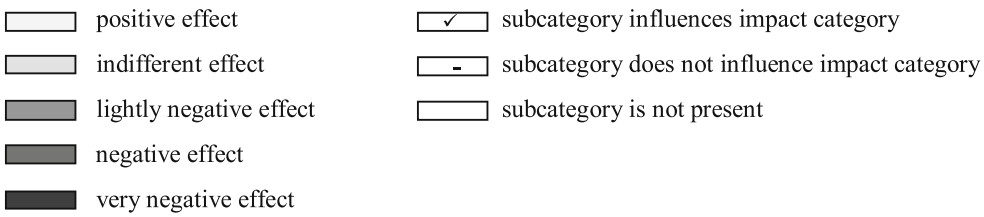
Consumers

- Consumer health and safety can only be affected by pesticide content of the flowers, there are statutory provisions, which prohibit the use of special pesticides, but there is no law limiting the contaminant content.
- In the EU, the "European Pollutant Release Transfer Register" obligates big companies from certain branches to report their emissions to ground, air and water as well as their waste transports. The data sets are published online, so that a high degree of transparency is achieved regarding environmental pollution of main emitters. Small firms do not have to report their emissions (Wetboek 2009; PRTR 2009). Concerning transparency about social conditions, there exist only voluntary guidelines, which include the publication of data. One example for these are the GRI-guidelines. The rose producer publishes only a few data regarding its environmental load. The social perspective is not considered.

5 Impact assessment

5.1 Social impacts

In this section the social performance of both companies with regard to the different processes in both countries are outlined. Each subcategory was evaluated with a colour.[6] The different shades represent following assessment categories:



[5] For example companies do not even try to get an approval for a pesticide in Europe or the USA, thus it is not forbidden there, consequently, it is allowed in Ecuador.

[6] Original version with colour shades from green to red

Table 5 Social impacts of rose producing in Ecuador

stakeholder group	subcategory	status	health and safety	socio-economic repercussions	human rights	indigenous rights	development of the country	assessment
workers	freedom of association	is not existent; labour contracts are missing	✓	✓	✓	✓	✓	
	discrimination	is existent	✓	✓	✓	✓	✓	
	child labour	is existent	✓	✓	✓	✓	✓	
	fair salary	is not existent: wages are far below national minimum wage	✓	✓	✓	✓	✓	
	working hours	72-84h/week	✓	✓	✓	✓	✓	
	forced labour	is not existent						
	health and safety	is at risks	✓	✓	✓	-	✓	
	social benefits	are not provided	✓	✓	✓	-	✓	
supply chain actors	fair competition	is existent	-	-	-	-	✓	
	promoting social responsibility	is not existent	✓	✓	✓	✓	✓	
local community	indigenous rights	are harmed	✓	✓	✓	✓	✓	
	safe and healthy living conditions	are degraded	✓	✓	✓	✓	✓	
	local employment	is promoted	✓	✓	✓	-	✓	
society	contribution to economic development	is existent, but unfair allocation: contrasting impacts	✓	✓	✓	✓	✓	
	corruption	is existent in company and is in addition promoted indirectly by unfair conditions	✓	✓	✓	✓	✓	
	technology development	is not promoted	✓	-	✓	-	✓	
	prevention of armed conflicts	is not promoted, but the company is not involved actively in armed conflicts	✓	✓	✓	-	✓	

Table 6 Social impacts of rose producing in the Netherlands

stakeholder group	subcategory	status	health and safety	socio-economic repercussions	human rights	indigenous rights	development of the country	assessment
workers	freedom of association	is existent	✓	✓	✓	-	✓	
	discrimination	is not existent						
	child labour	is not existent	✓	✓	✓	-	✓	
	fair salary	is existent: minimum wage is paid	✓	✓	✓	-	✓	
	working hours	38h/week	✓	✓	✓	-	✓	
	forced labour	is not existent						
	health and safety	is at low risk	✓	✓	✓	-	✓	
	social benefits	are provided	✓	✓	✓	-	✓	
supply chain actors	fair competition	is existent	-	-	-	-	✓	
	promoting social responsibility	is existent	✓	-	✓	-	✓	
local community	indigenous rights	not applicable						
	safe and healthy living conditions	are harmed by pollution	✓	-	✓	-	✓	
	local employment	is not promoted	-	✓	✓	-	✓	
society	contribution to economic development	is existent	✓	✓	✓	-	✓	
	corruption	is not existent						
	technology development	is promoted	✓	-	-	-	✓	
	prevention of armed conflicts	is existent	✓	✓	✓	-	✓	

The colour scheme is simple to apply and easy to understand. The scheme is put forward for discussion in this paper.

The considered impact categories are based on the UNEP/SETAC guidelines and include impacts to health and safety, socio-economic repercussion, impacts to human rights, impacts to indigenous rights (including cultural heritage), and impacts to development of the country.

5.1.1 Rose production

The following tables illustrate the social impacts caused by rose production. They summarize the indicators described in chapter 4.1 per subcategory and assess them.

Production in Ecuador (Table 5)

Production in the Netherlands (Table 6)

5.1.2 Cutting and packaging

The following tables show the social impacts caused by cutting and packaging; based on the circumstances explained in chapter 4.2.

Cutting and packaging in Ecuador (Table 7)

Cutting and packaging in the Netherlands (Table 8)

5.2 Environmental impacts

To calculate the environmental impacts the life cycles of both rose bouquets were considered. Impact categories are abiotic depletion, acidification, eutrophication, global warming, ozon layer depletion, human toxicity, fresh water aquatic ecotoxicity, marine aquatic ecotoxicity, terrestrial ecotoxicity, and photochemical oxidation.

The comparison shows that the effects caused by Dutch roses exceed the impacts of Ecuadorian roses at large in every category, with exception of ozone layer depletion, in which Ecuadorian roses outvalue Dutch roses by 23% (Fig. 3).

An investigation of the Dutch life cycle reveals that the high-energy consumption is main responsible for the environmental impacts. Impacts in the category global warming are dominated by energy demand, which contributes 98.9%. The residual 1.1% are mainly caused by the glazing of the greenhouses (0.35%) and by the production of plastic (0.12%). For Ecuadorian roses, energy demand of the production process is responsible for about 35% of the global

Table 7 Social impacts of cutting and packaging in Ecuador

stakeholder group	subcategory	status	health and safety	socio-economic repercussions	human rights	indigenous rights	development of the country	assessment
workers	freedom of association	is not existent: labour contracts are missing	✓	✓	✓	✓	✓	
	discrimination	is existent	✓	✓	✓	✓	✓	
	child labour	is existent	✓	✓	✓	✓	✓	
	fair salary	is not existent: wages are far below national minimum wage	✓	✓	✓	✓	✓	
	working hours	72-84h/week	✓	✓	✓	✓	✓	
	forced labour	is not existent						
	health and safety	is at low risks	✓	-	-	-	-	
	social benefits	are not provided	✓	✓	✓	-	✓	
supply chain actors	fair competition	is existent	-	-	-	-	✓	
	promoting social responsibility	is not existent	✓	✓	✓	✓	✓	
local community	indigenous rights	are harmed	✓	✓	✓	✓	✓	
	safe and healthy living conditions	are degraded	✓	✓	✓	✓	✓	
	local employment	is promoted	✓	✓	✓	-	✓	
society	contribution to economic development	is existent, but unfair allocation: contrasting impacts	✓	✓	✓	✓	✓	
	corruption	is existent in company and is in addition promoted indirectly by unfair conditions	✓	✓	✓	✓	✓	
	technology development	is not promoted	✓	-	✓	-	✓	
	prevention of armed conflicts	is not promoted, but the company is not involved actively in armed conflicts	✓	✓	✓	-	✓	
consumers	health and safety	is not at risk	-	-	-	-	-	
	transparency	is not existent	✓	-	✓	-	-	

Table 8 Social impacts of cutting and packaging in the Netherlands

stakeholder group	subcategory	status	health and safety	socio-economic repercussions	human rights	indigenous rights	development of the country	assessment
workers	freedom of association	is existent	✓	✓	✓	-	✓	
	discrimination	is not existent						
	child labour	is not existent	✓	✓	✓	-	✓	
	fair salary	is existent: minimum wage is paid	✓	✓	✓	-	✓	
	working hours	38h/week	✓	✓	✓	-	✓	
	forced labour	is not existent						
	health and safety	is not at risk	✓	-	-	-	✓	
	social benefits	are provided	✓	✓	✓	-	✓	
supply chain actors	fair competition	is existent	-	-	-	-	✓	
	promoting social responsibility	is existent	✓	-	✓	-	✓	
local community	indigenous rights	not applicable						
	safe and healthy living conditions	are harmed by pollution	✓	-	✓	-	✓	
	local employment	is not promoted	-	✓	✓	-	✓	
society	contribution to economic development	is existent	✓	✓	✓	-	✓	
	corruption	is not existent						
	technology development	is promoted	✓	-	-	-	✓	
	prevention of armed conflicts	is existent	✓	✓	✓	-	✓	
consumers	health and safety	is not at risk	-	-	-	-	-	
	transparency	partly assured	✓	-	-	-	✓	

warming impacts. The main impact of 57% is caused by the transport from Ecuador to the Netherlands via airplane. More than 5% of effects are traceable to the production of fertilizers and near 3% to the production of plastic.

6 Comparison and conclusions

The rose production in Ecuador is associated with a multitude of social issues. International conventions, codes of conducts, and laws are not fully observed. As a result, social ills become even worse through rose plantations, in spite of providing jobs in rural regions, which are in fact very important for the rural population. The low payment, the exploitation of (child) labour, and the impacts of careless pesticide use have nevertheless a negative contribution to living conditions. Each red, orange, and yellow coloured indicator represents a problem area with many direct and indirect effects; a detailed description of each goes beyond the scope of this paper. Since also the closing of the rose farms would have serious consequences for the local society, an improvement of the situation is recommended.

The Dutch rose production induces mainly positive social impacts. One disadvantage is the low employment rate due to the high automatization. On the other hand, this high degree of automatization leads to only very little health effects.

From an ecological perspective, the effects of Dutch roses exceed those from Ecuadorian roses drastically in almost every impact category. The environmental assessment shows that processes like fertilizing or spraying of pesticides carry hardly any weight. Determining factors for the environmental impacts are the energy consumption and the transport. This contribution is in the Netherlands, caused by heating, lighting, and the high degree of automatization, much higher than in

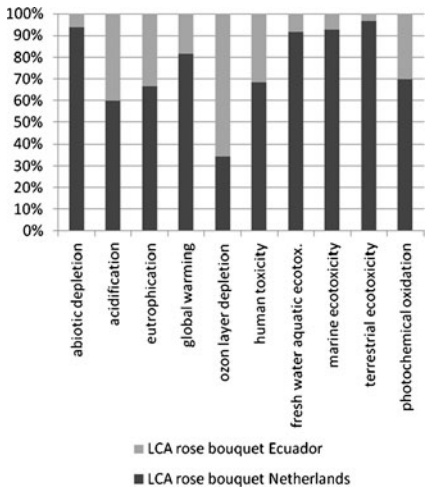


Fig. 3 Comparison of the environmental impacts of cut roses from Ecuador and the Netherlands

Ecuador. Thus, from an ecological point of view, it is better to fly-in roses from Ecuador, in spite of long distance.

The UNEP/SETAC Guidelines were well applicable for the case study. The inclusion of five different stakeholder groups (workers, local community, society, value chain actors, and consumers) allows a comprehensive consideration of the prevailing situation. In addition, the wide range of subcategories covers nearly all possible social issues caused by products/companies. The determination of suitable indicators is in some cases a little bit tricky and needs more attention in future. The development of a default set of subcategories and corresponding indicators would be helpful for future studies.

The case study presented in this article shows that the evaluation of social impacts is possible, even if the assessment is always affected by subjective value systems. The setting of performance reference points based on international conventions and standards enables some objectivity and transparency in the assessment phase. The simple and intuitive result presentation helps to identify the major issues in life cycles and product systems.

7 Recommendations and perspectives

Considering the ecological dimension of rose production today, one is forced to the conclusion that it is eco-friendlier to import roses from Ecuador, particularly in winter when heating and lighting is required in European latitudinal lines. FIAN-Deutschland e.V. initiated recently a project with the aim to enable a climate neutral rose production in Ecuador (Flower Label Program 2010).

Social conditions considered it could make sense to produce roses in Ecuador: Plantations generate jobs in rural regions with high poverty, where one third of the population lives. If these jobs were paid in a fair manner and if working conditions were improved in general, living conditions in Ecuador could be greatly improved. For example, with the aid of better payment, child labour would be avoided and a better education enabled. Education reduces poverty and generates a higher income. Increased buying power fosters local economy, which in turn enables the government to invest in the welfare system, health care, education, and so on. Hence, flower production could contribute at least noticeable to the regional development.

Useful codes of conduct exist to improve conditions in the flower production, but they are not widespread yet. Certification schemas exist as well, but they vary in criteria and it is not for all granted if they base on reliable monitoring tools.

The application of the UNEP/SETAC guidelines was possible with reasonable effort, but based on a rather clear case. Also, for matter of effort, real data were barely available. Within this case, clear recommendations were available (see above), which also show that social and environmental performance of a product over its life cycle can differ drastically. A logical consequence is that in sustainability assessment, both a social and an environmental assessment are required to obtain a complete picture.

On a more general note, it will be interesting to apply the method of S-LCA as developed by the UNEP/SETAC group to other products; especially products with a more complex life cycle will be a challenge. As with any new method, getting experience on data collection and evaluation, building a data stock, integrating the method in life cycle software, and finding ways for effective communication of results are important steps until integrating S-LCA in routine, recognized decision support.

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